

Software and Procedures for Incorporating NASA and NAAPS Products into DataFed Analysis and DSS

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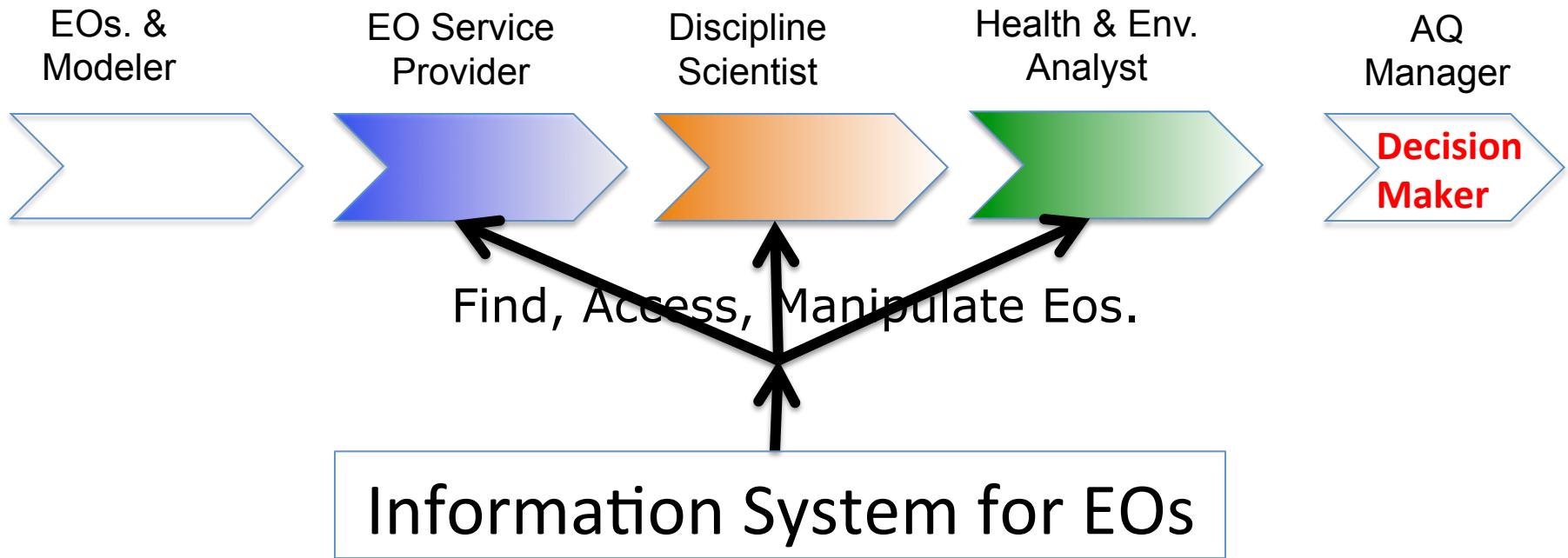
GEO Air Quality Community of Practice
EPA, State Analysts

Air Quality Decision System



- Air Quality Management is an intensely human process and includes a spectrum of participants (G. Foley, EPA).
- The **Decision Maker** is the **AQ Manager** who uses multiple sources of information to make decisions and initiate actions.
- She relies on **Env. Health Analyst** for information and guidance.
- The Analysts use observations and knowledge from **Discipline Scientists**
- The Analysts and Scientists get the data from the **EO Service Provider**

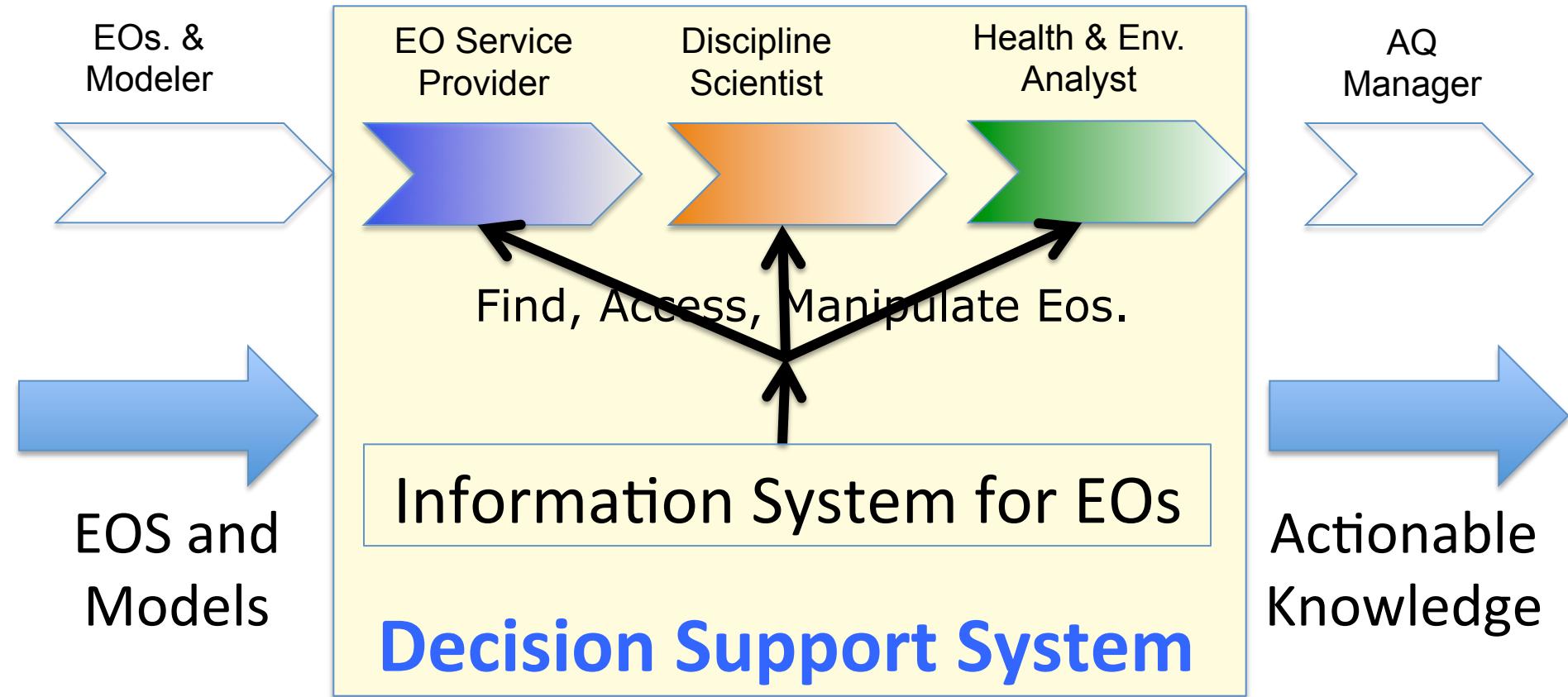
Air Quality Decision Systems



These Users need to **find**, access and manipulate EO and models.
They need support from a suitable Information System (IS)
Traditionally, the IS was a ‘stovepipe’ dedicated to each application

Air Quality Decision Systems

(G. Foley, EPA)

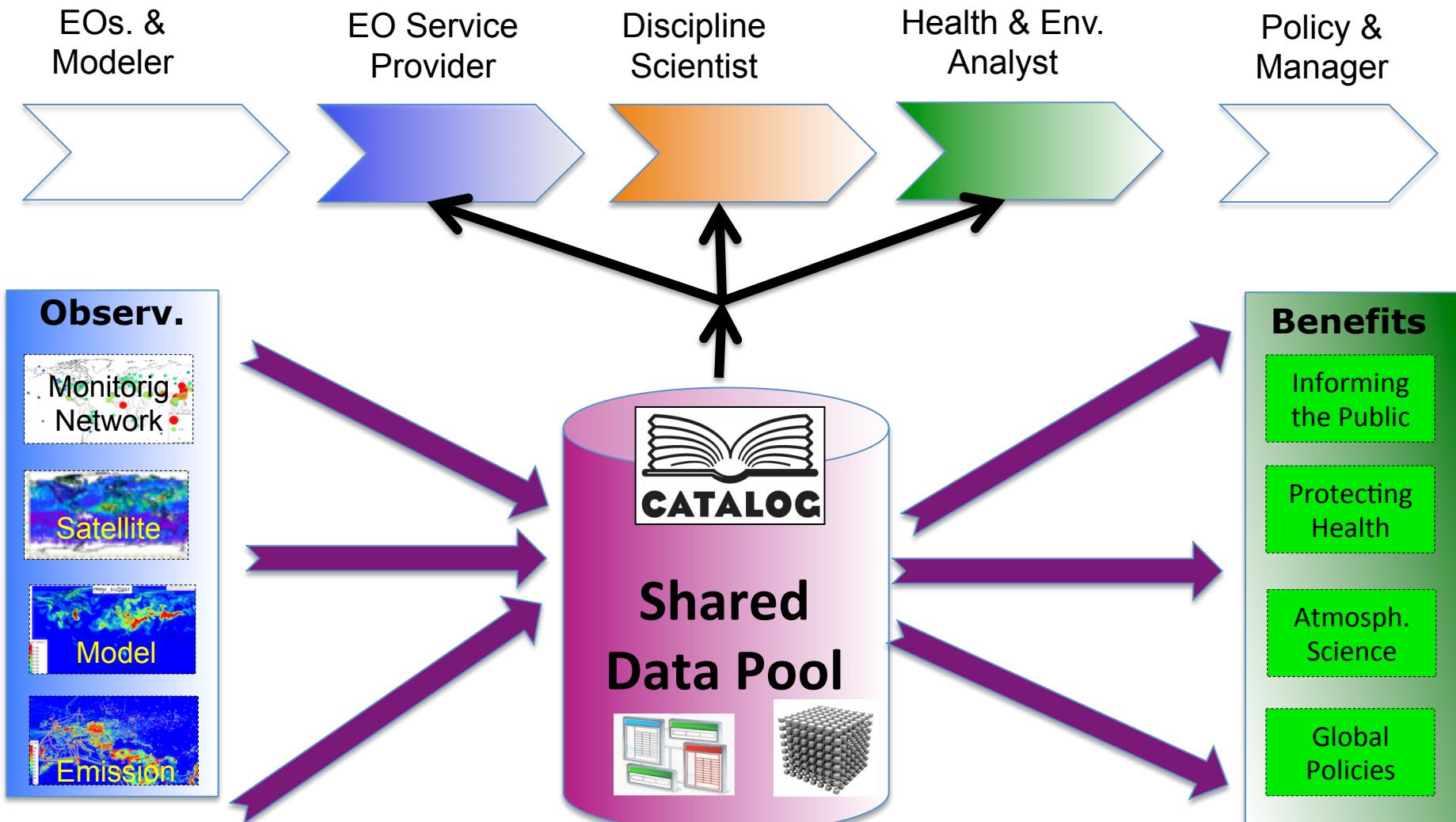


DSS is the combination of humans AND the supporting IS.

The inputs to this system are Earth Observations and Models.

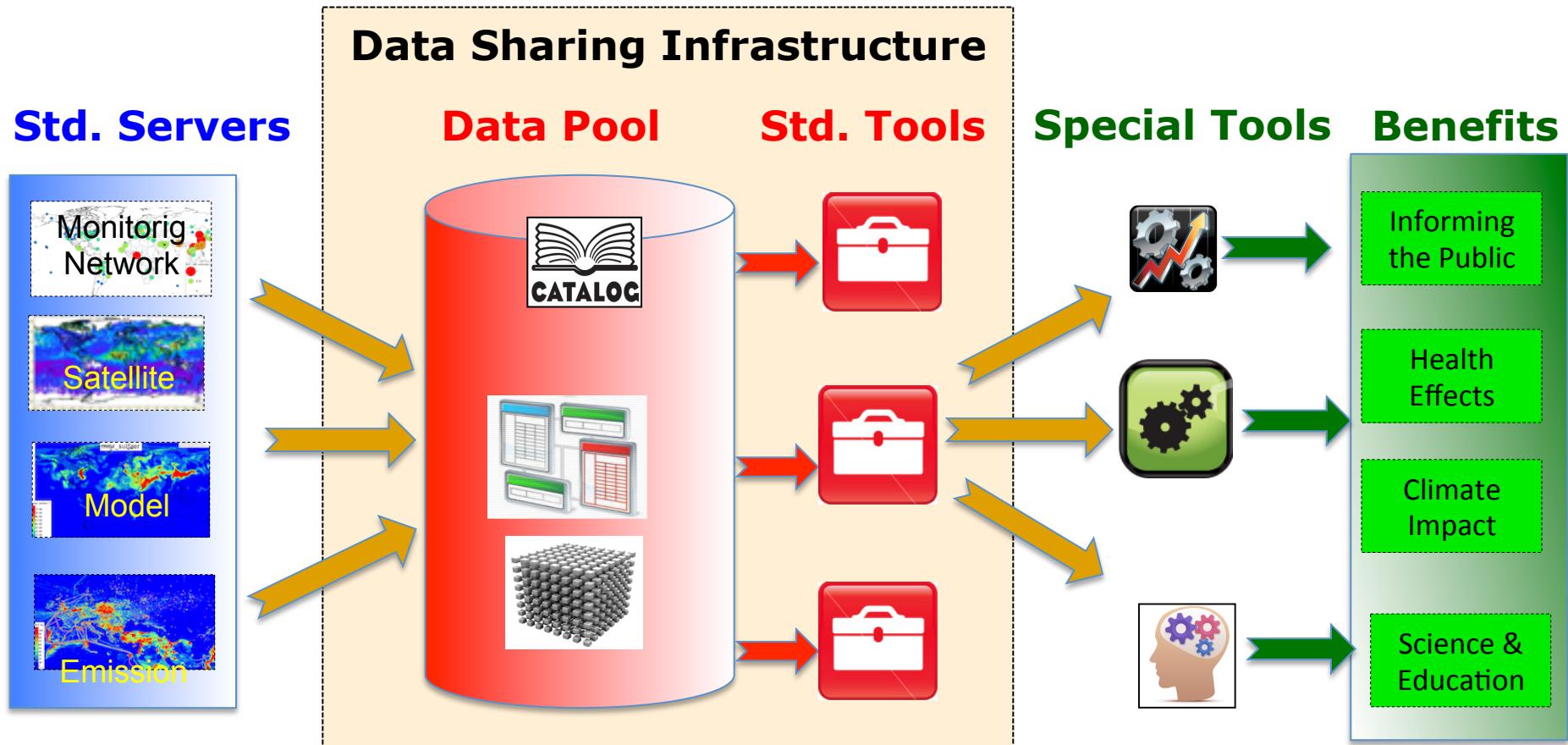
The output is **Actionable Knowledge** for the Manager/Decision Maker.

Air Quality Decision Systems



In the new GEOSS paradigm, EOs should be accessible from a shared virtual data pool

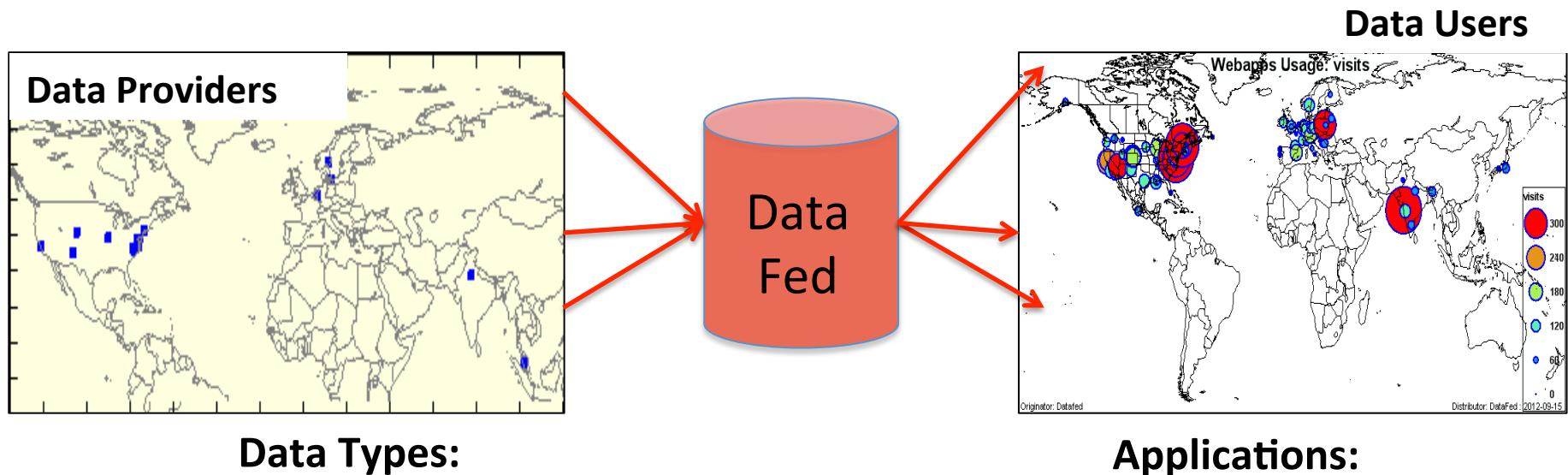
DataFed Information Infrastructure



DataFed also includes client applications for data browsing, exploration and analysis. These flexible tools can be used on any dataset from anywhere on the Web.

Distributed Data System DataFed

An implementation of the GEOSS paradigm at Washington University

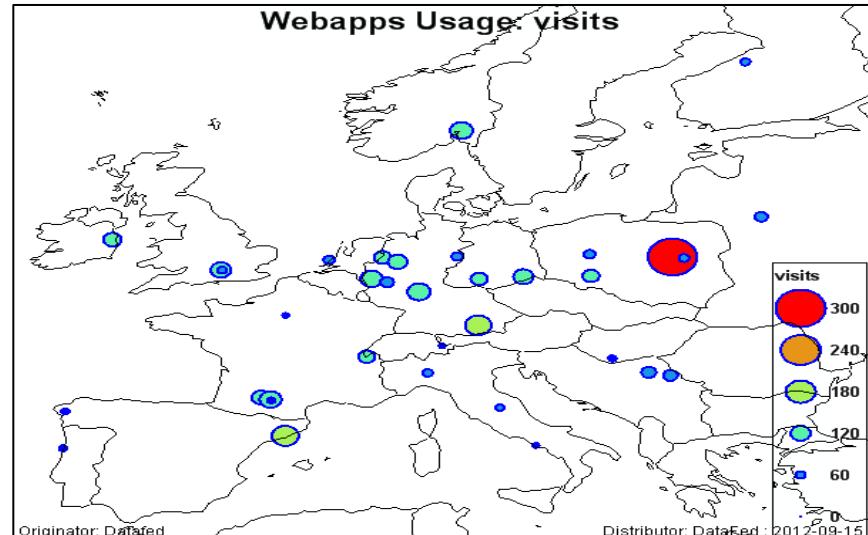
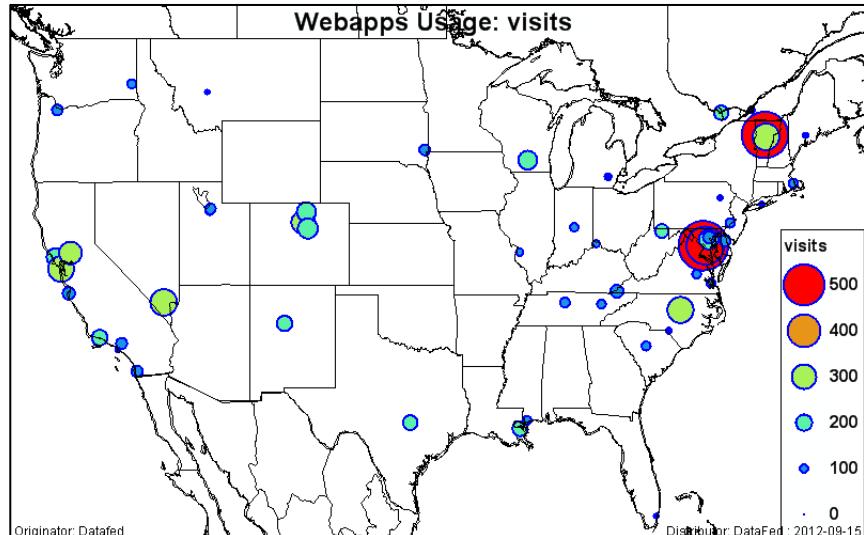


Surface Obs: AirNOW, AQS, AirBase
Satellites: MODIS, OMI
Emissions: NAAPS, EDGAR
Models: NAAPS, MACC, CMAQ

Forecasting: NE US
AQ Managm.: ESs – EUS,
Atm. Science: IIT Bombay
Inform Public: ?? Web
users

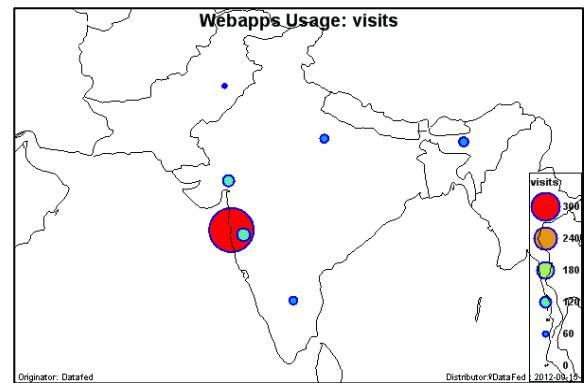
Since 2008, DataFed is used globally

DataFed Usage Metric by Google Analytics: Data Access by top 100 Users
Top 100 user averages: 70 visits; 6:20 minutes per session; 4.5 per pages/session

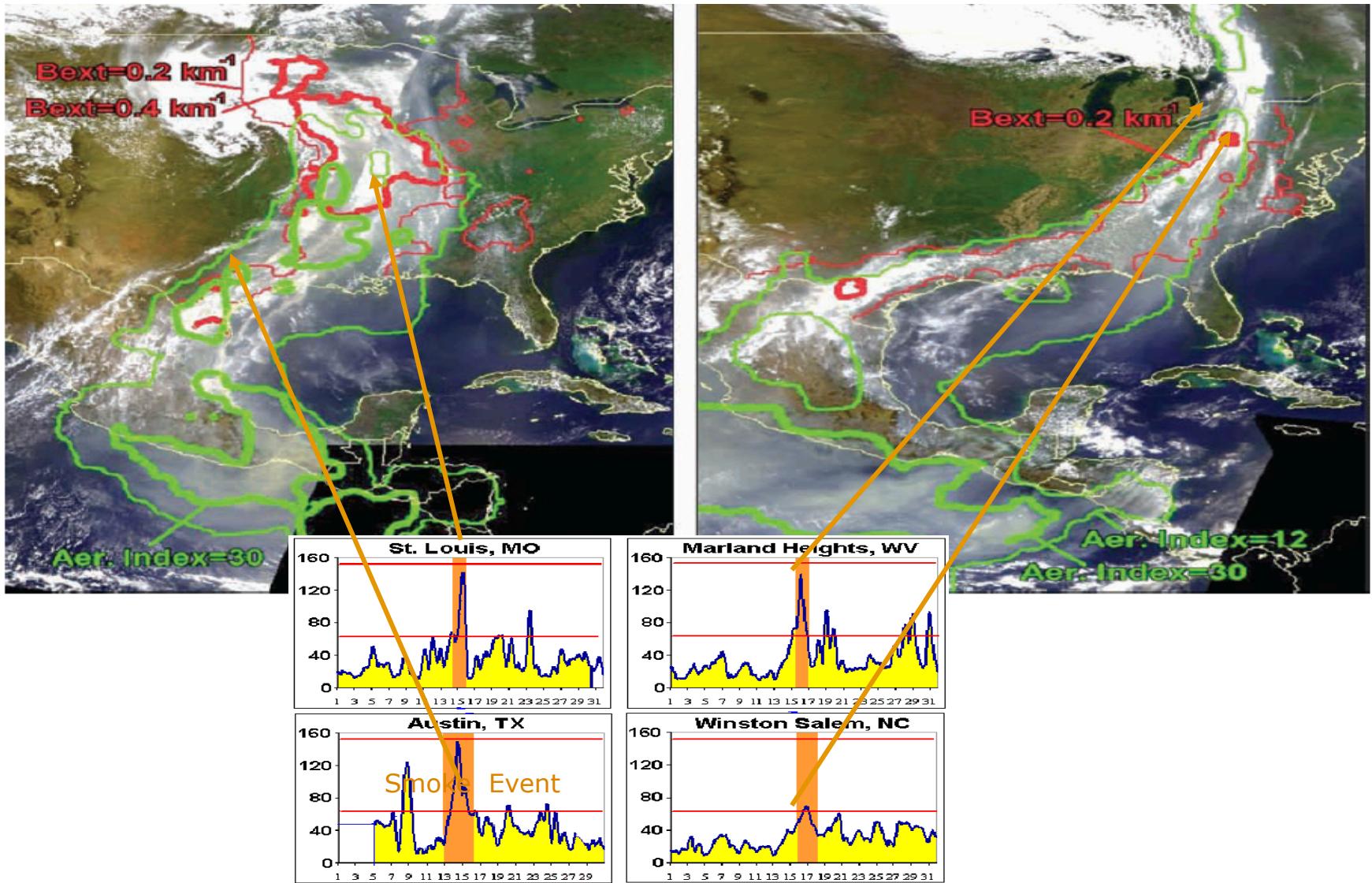


Top User Sites, Visits

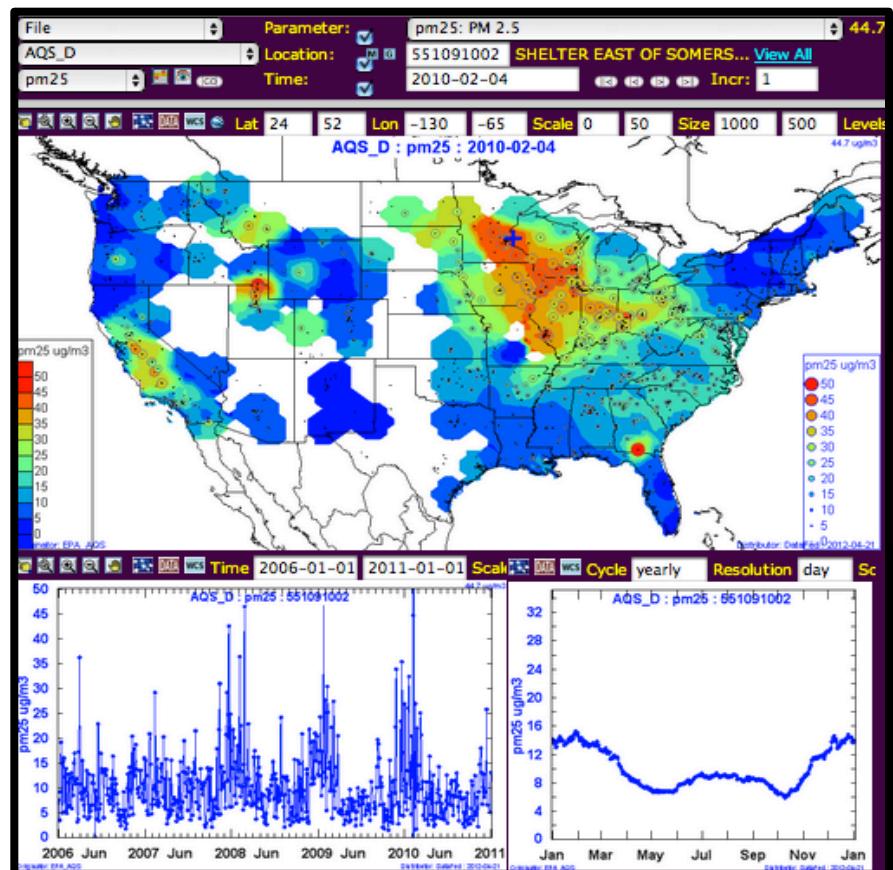
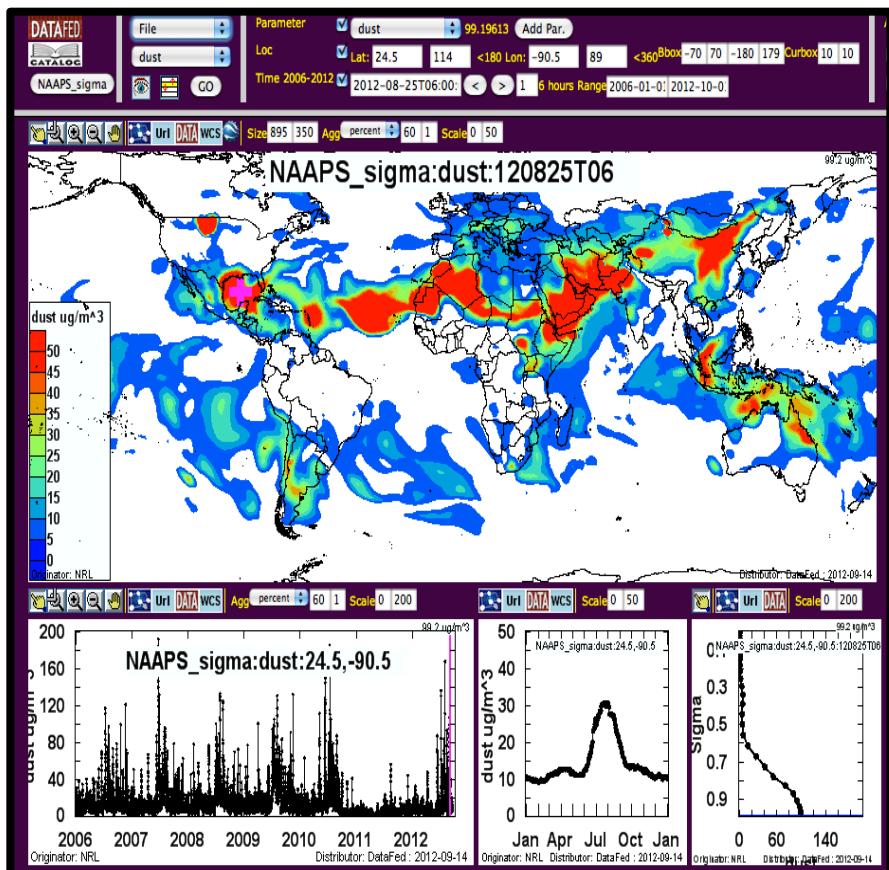
Mumbai, India,	742 : AQ analysis, research
Washington DC,	736: ?
Waterbury, VT,	642: AQ Forecasting, NE
Greenbelt, MD,	429: ?
Warsaw, PL,	242: AQ Analysis, research
Las Vegas, NV,	211: ?
Raleigh, NC,	202: ?



AQ Events: Important for health

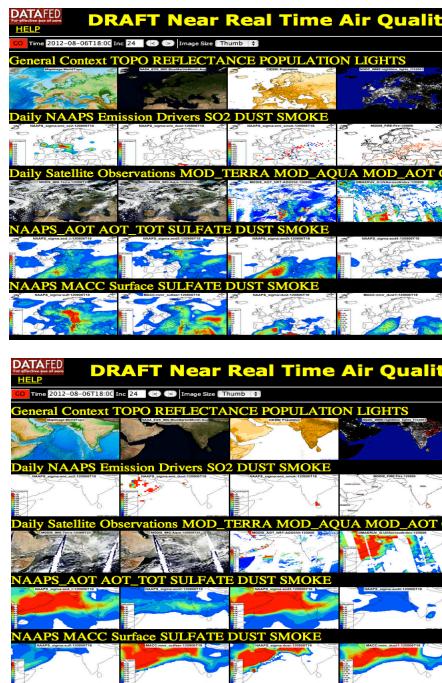
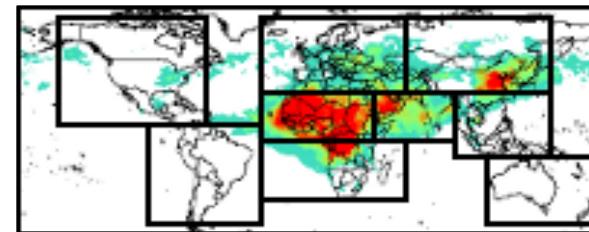
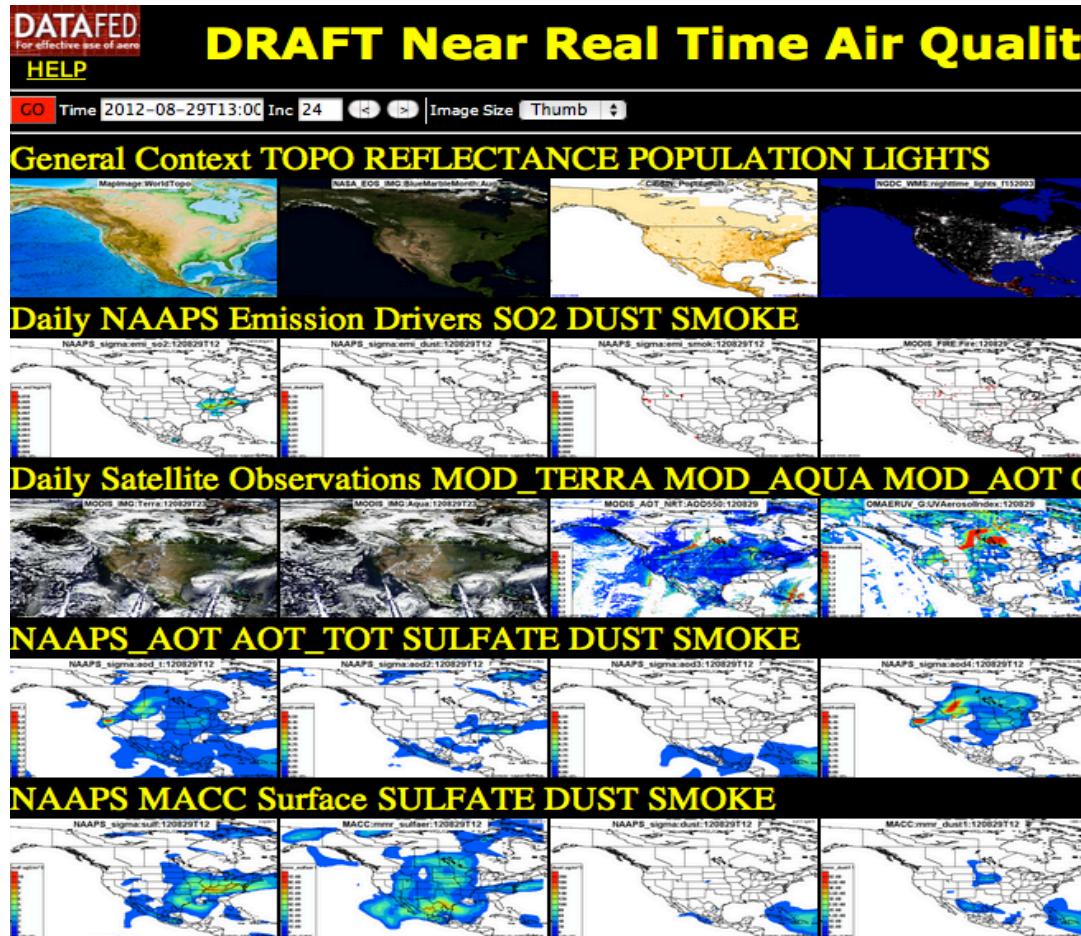


Tools: Data Browser



Every shared dataset can be browsed for spatial and temporal pattern

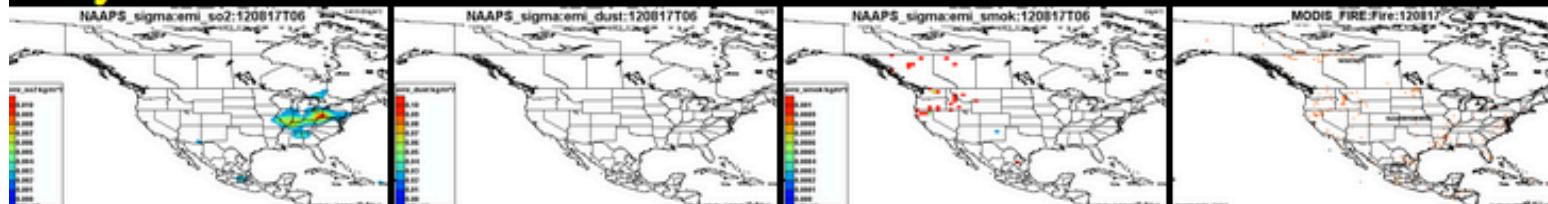
Tools: Near Real Time Consoles



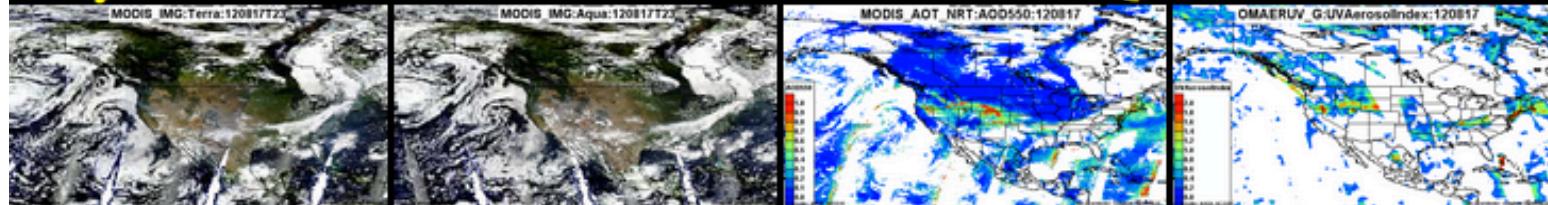
Consoles are spatial representations of observations, emissions and models.
All maps are synchronized spatially and in time, and moved by the user
Provide rich multisensory context to illuminate complex atmospheric situations

Tools: August 2012 Western US Fires

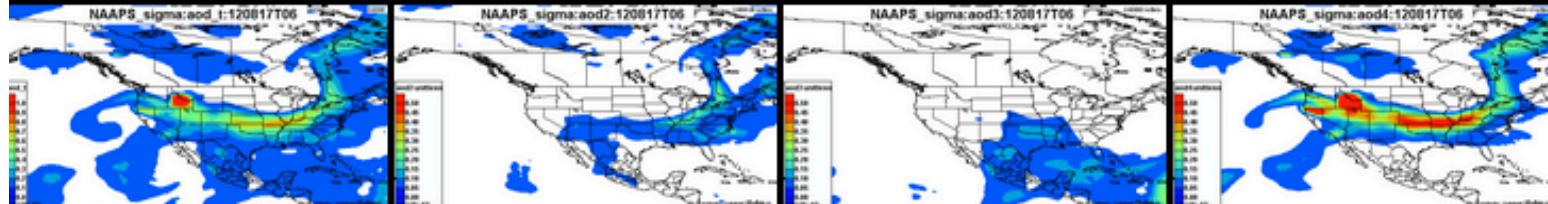
Daily NAAPS Emission Drivers SO₂ DUST SMOKE



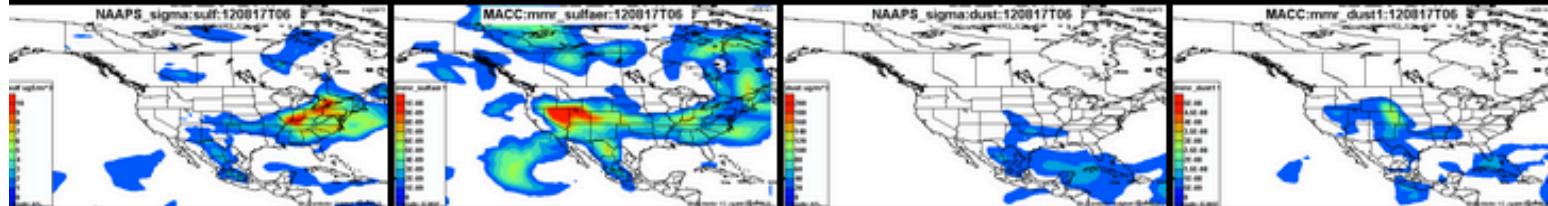
Daily Satellite Observations MOD_TERRA MOD_AQUA MOD_AOT OM



NAAPS_AOT AOT_TOT SULFATE DUST SMOKE

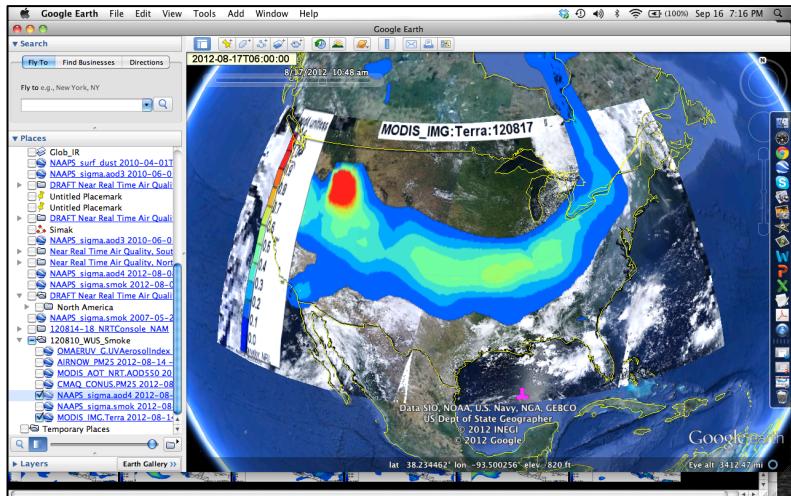
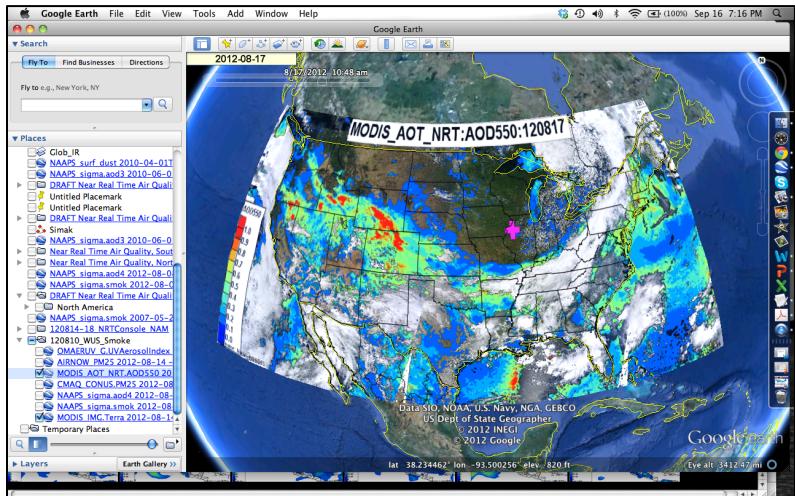
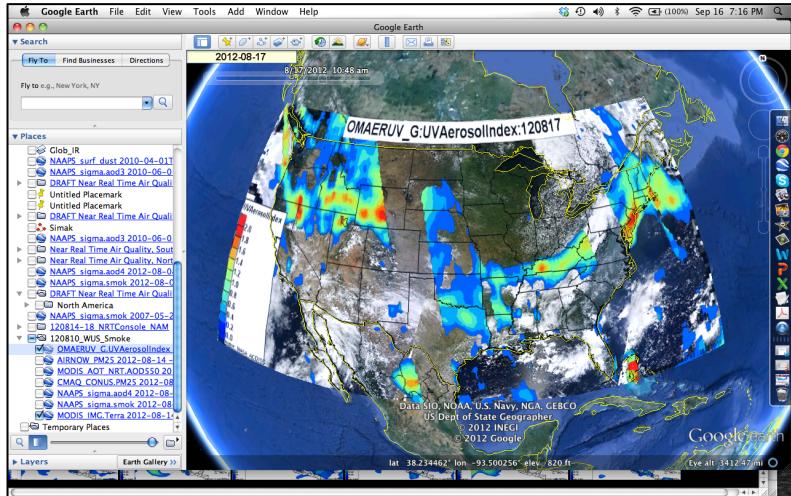
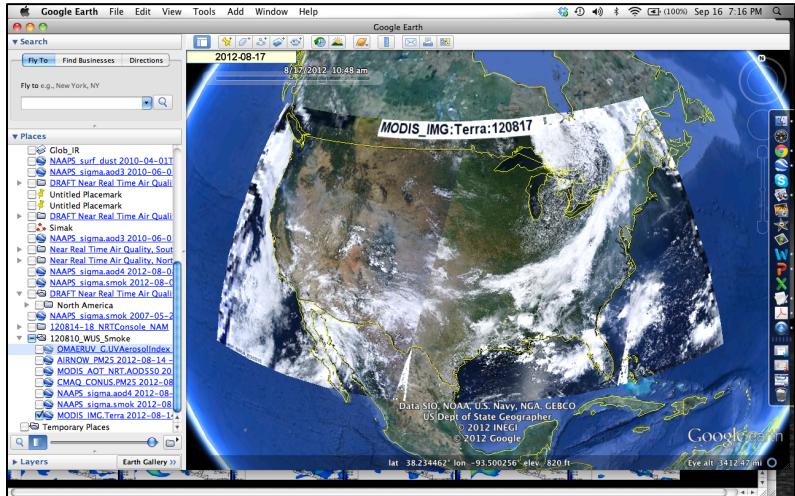


NAAPS MACC Surface SULFATE DUST SMOKE



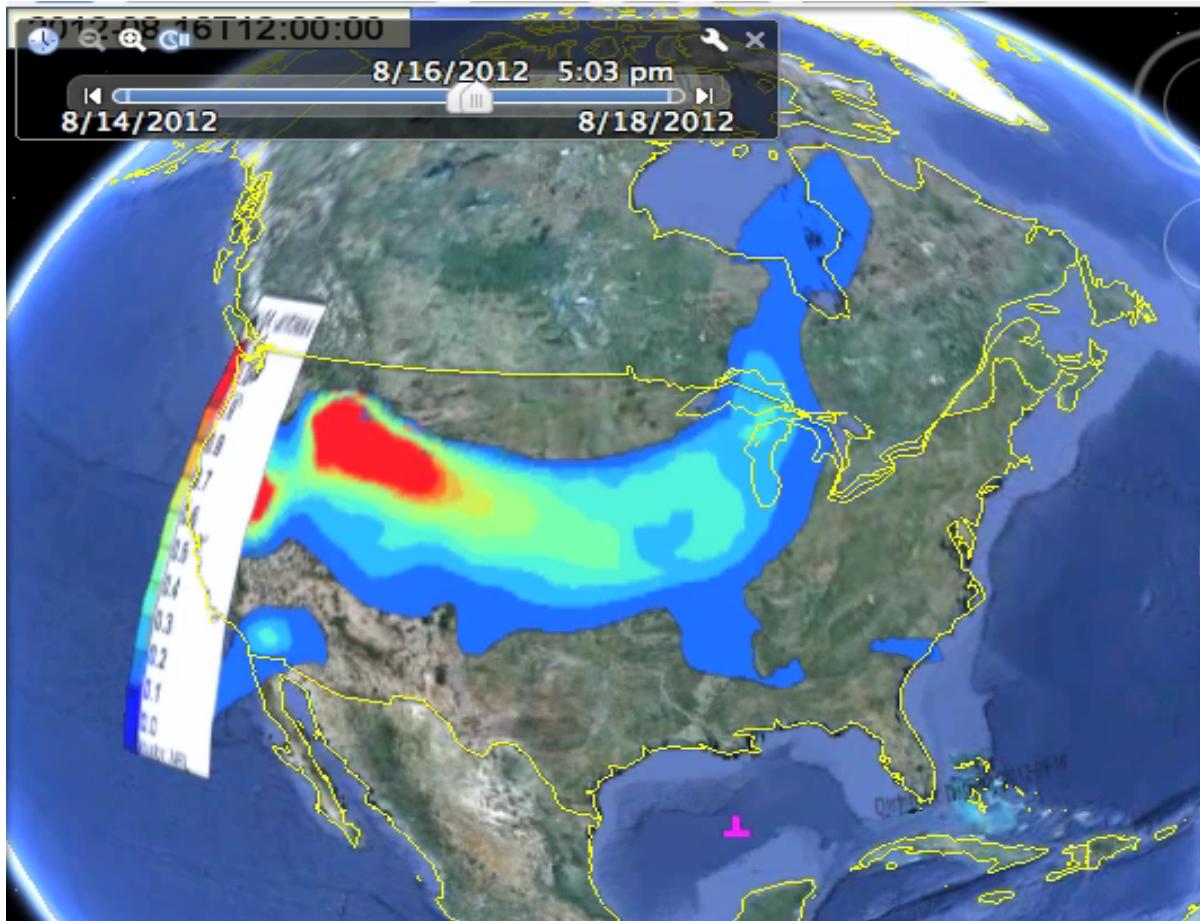
A smoke event such as occurred this in August over the Western US, can be examined through the emissions, satellite observations and models.

Tools: August 2012 Western US Fires



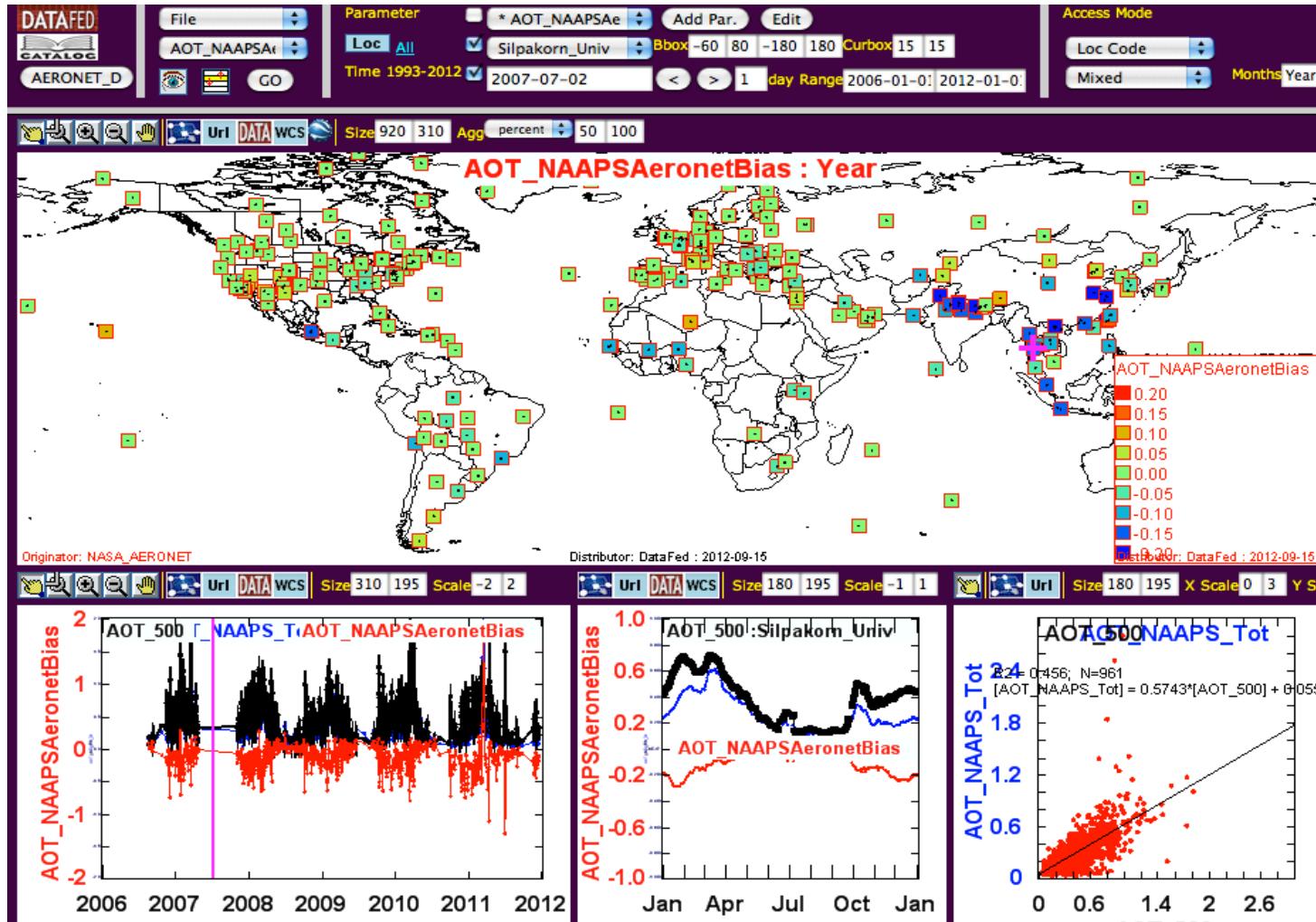
When the contents of a console is exported to Google Earth one can choose any combination of overlays, and zoom...

Tools: August 2012 Western US Fires



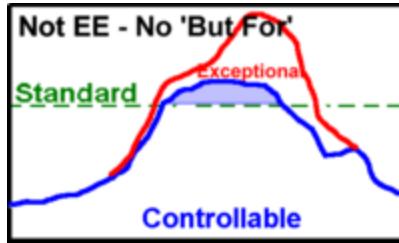
For user-selectable time range, the transport pattern can be visualized through animations
With these tools, event analysis is faster, richer and can be more robust

Tools: Model Evaluation Tool



Model bias can be evaluated using any space-time-compatible observational data sets
Example: NAAPS model AOT compared to AERONET AOT.

Exceptional Events: Regulatory Definition



An EE occurs when the exceedance happens only due to the increment of the uncontrollable source. (Exceedance would not happen 'but-for' the EE source)

States can flag smoke, windblown dust events, trans-boundary transport etc. as Ees. Those will not count in the calculation of compliance with NAAQS. However, States need to supply evidence for the 'but-for' condition; satellites and model are explicitly allowed as evidence. The EPA regulations require a four-step documentation of Exceptional Events:

Exceptional Events: Decision Support System (EE DSS)

EE DSS supports:

- **State AQ Analyst:** Detection of candidate Ees; preparation of the EE documentation
- **EPA Region AQ Analyst:** Independent EE assessment of EE flags; approval/disapproval
- **Independent Analysts:** General research on AQ events to help States/Regions

A: General Event Description

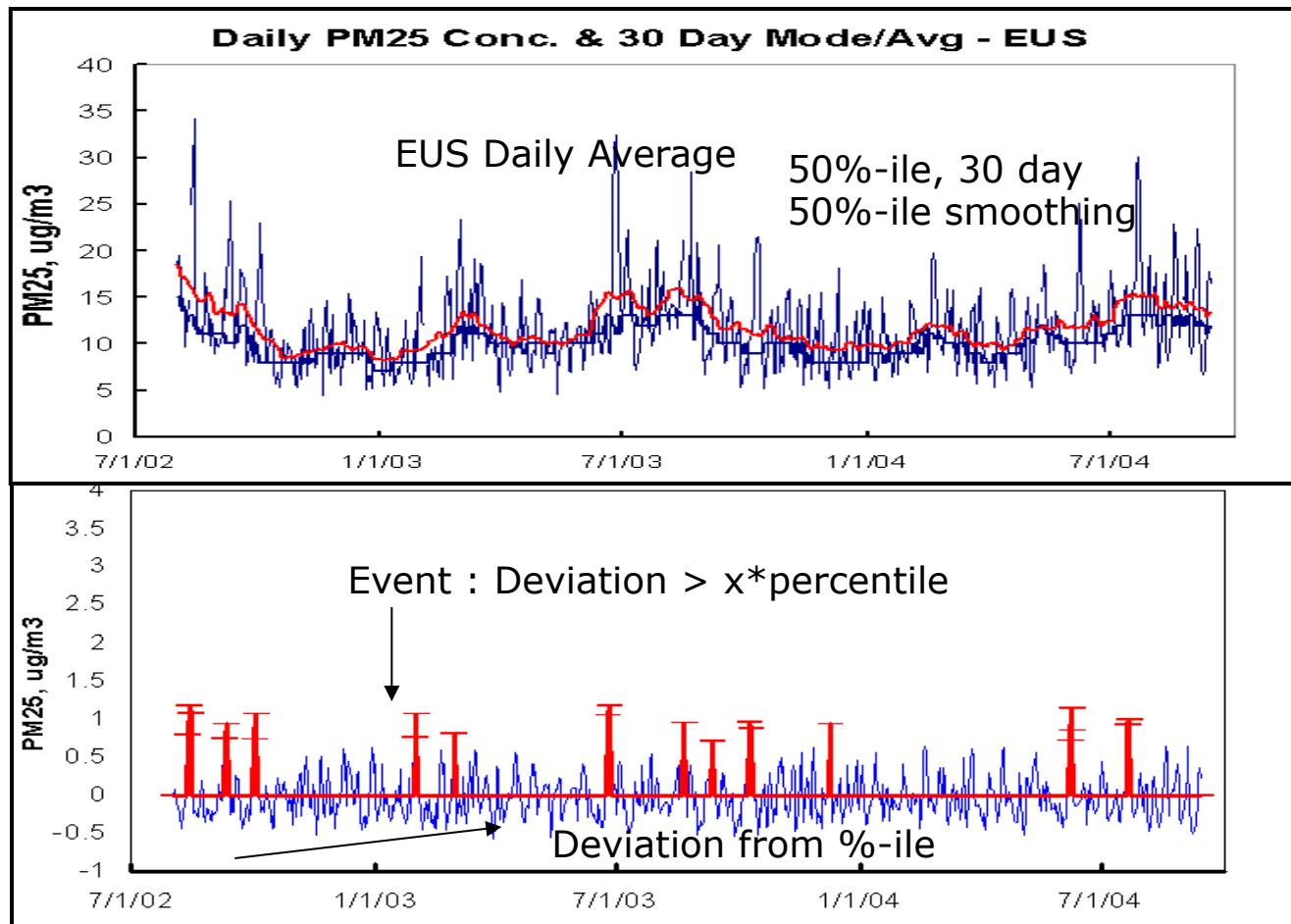
B: Clear Causal Relationship between the Observations and the Cause

C: The Event is in Excess of the "Normal" Values

D: The Violation would not have Occurred, 'but for' the Exceptional Event

The NAAPS products can support steps A and B. The tools for documenting and quantifying the events are include software for visualization of spatial and temporal pollutant pattern, filtering and aggregation of datasets and tools to fuse the multi-sensory data to represent the air pollution events.

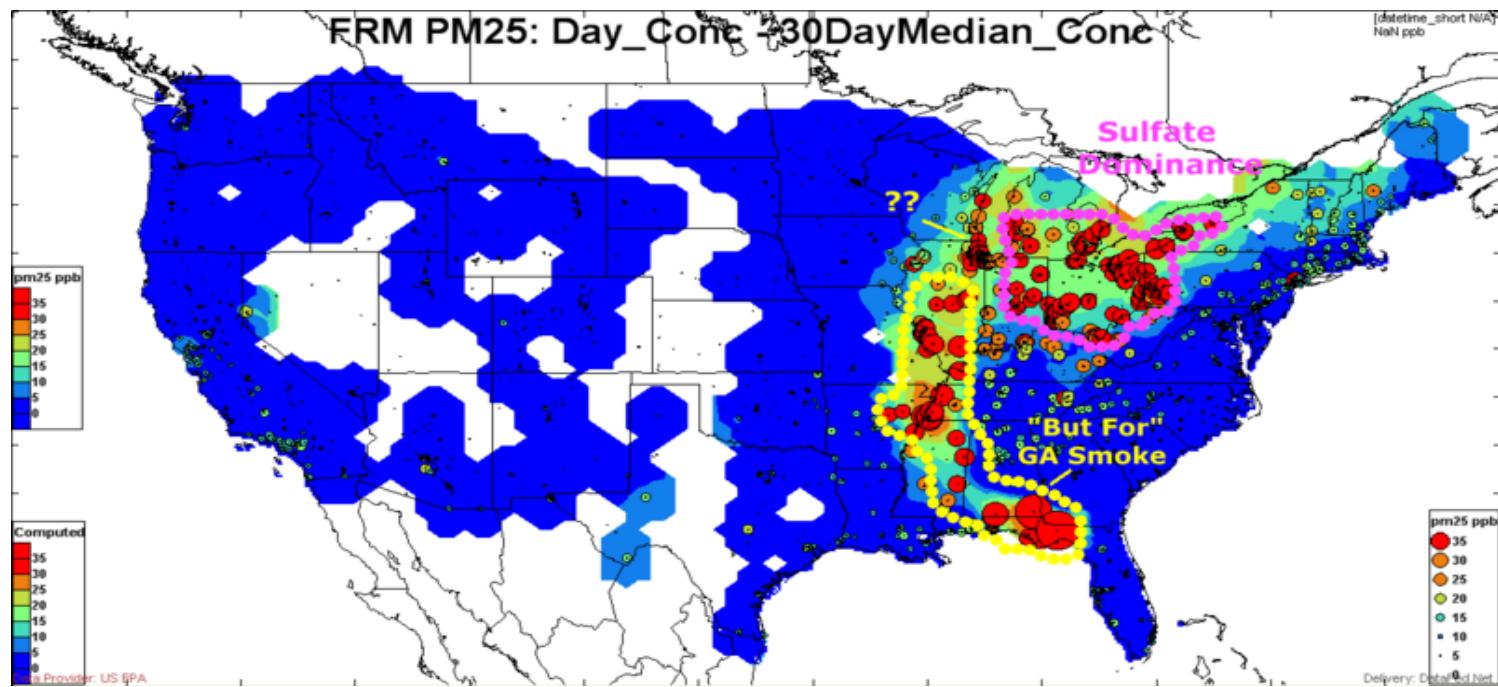
Tools: Automatic Event Detection



Air quality events can be detected as anomalies, compared to a set baseline condition. Calculating the baseline and setting trigger values are flexible.

Exceptional Events: Base Case

Okefenokee (GA/FL) Smoke, May 24, 2006



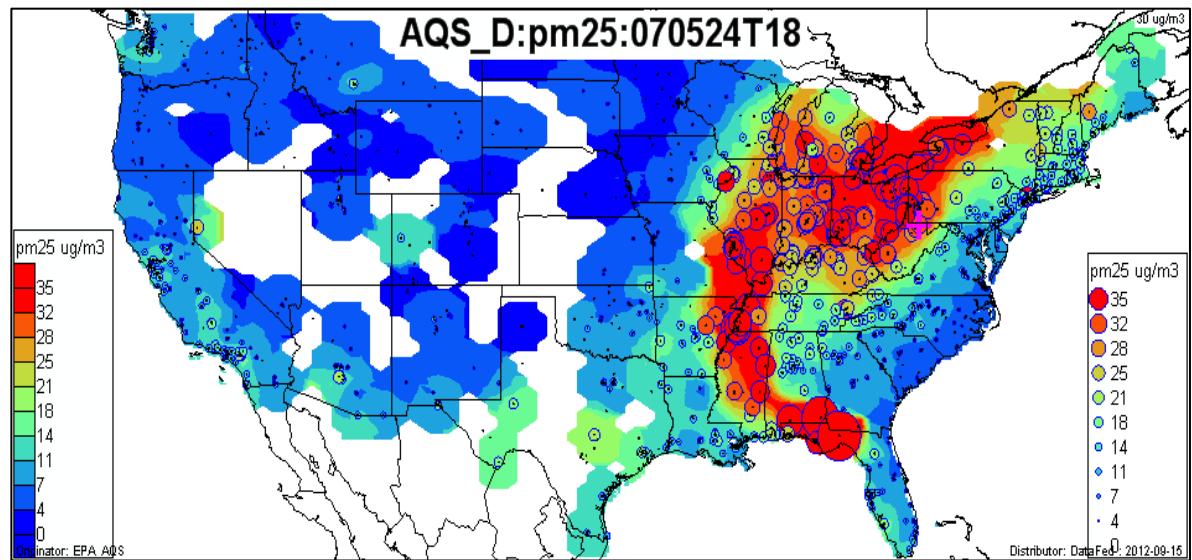
Effort to determine the zone of “Exceptional PM2.5” concentrations:

3 weeks of research (EPA, GA/FL, WashU) ~ 100 man-hours_

EE Analysis: Project Metric

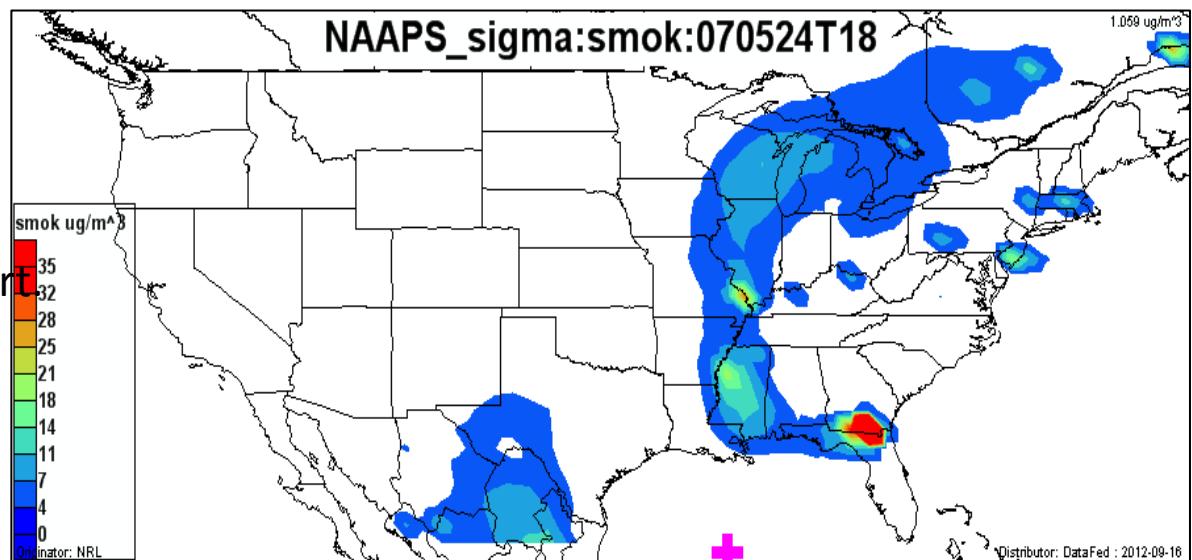
Base Case: 2007

- EPA, GA, FL, TN
- 2-3 person months
- Weak evidence for EE



DataFed EE DSS Tools: 2012

- 3 hours with new tools
- Strong evidence for EE
- Key: NAAPS smoke transport



Partnerships, Linkages

Collaborative Projects

Sub to NRL, Westphal, 2009-13: NASA and NAAPS products for AQ Decision Making.

[WUSTL: Make NAAPS analysis available to the AQ community via DataFed.](#)

Sub to BAMS, McHenry, 2008-12: Assimilating AURA-derived Trace Gas Retrievals and MODIS AOD into an Operational Multi-pollutant Air Quality Forecast DSS.

[WUSTL: CMAQ evaluation and delivery to the AQ Community through DataFed](#)

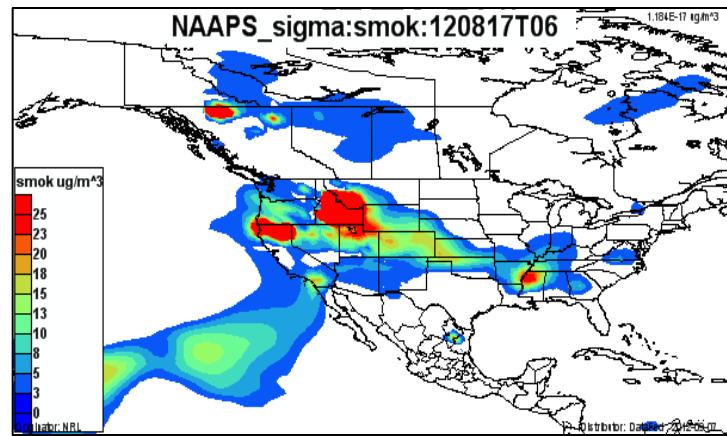
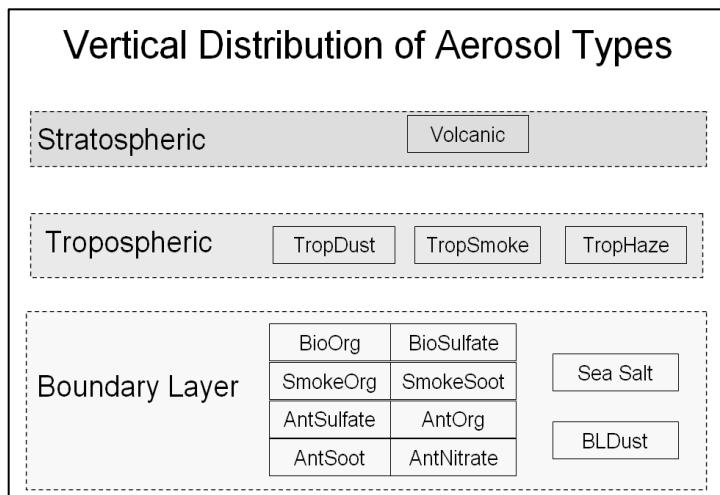
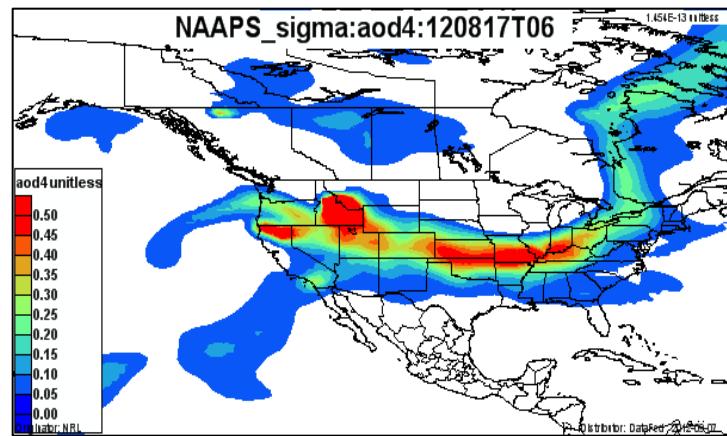
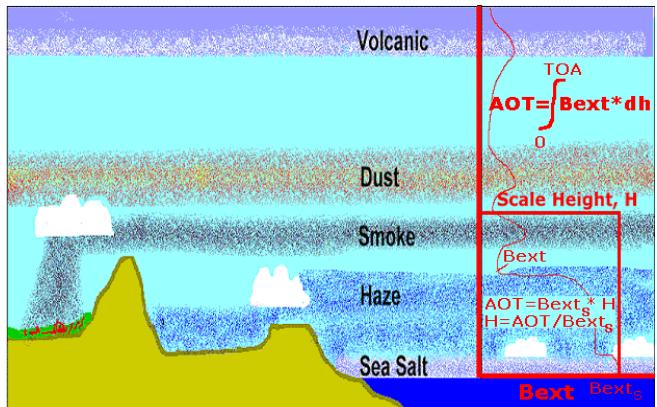
EPA – HTAP Model Evaluation Network 2010-12

[WUSTL: Model Evaluation Tool](#)

Air Quality Community of Practice

Community Server software, Community Catalog, Coordinator India AQ Community of Practice, Lesion with

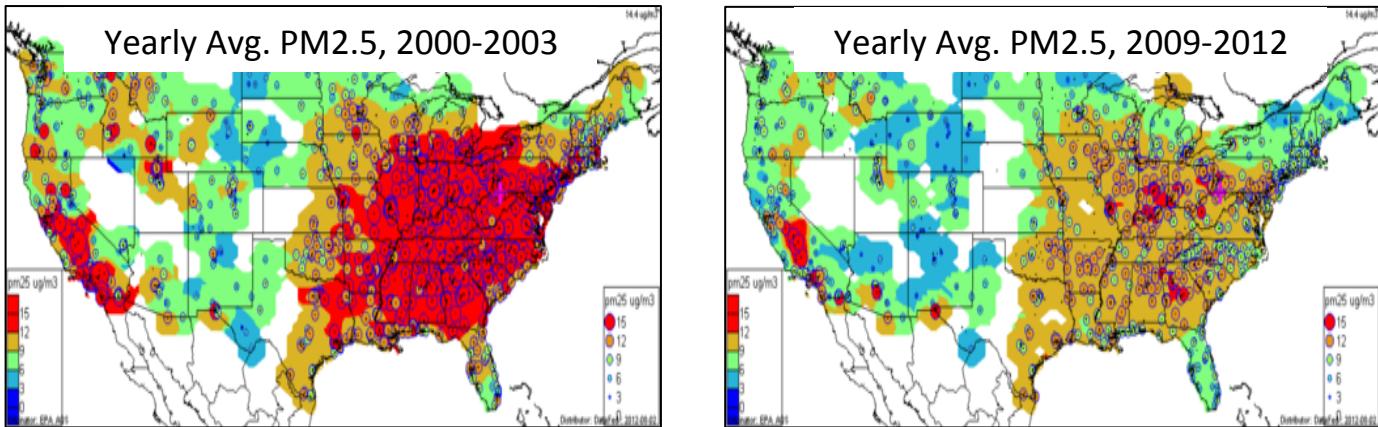
Challenge: Satellite-Surface PM link



Issue: Where have all the EEs Gone?

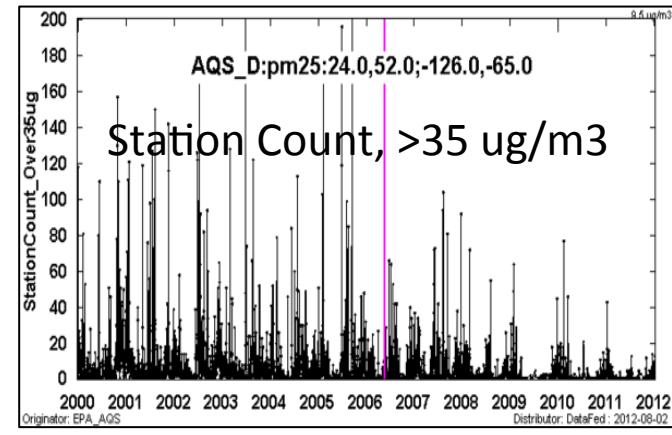
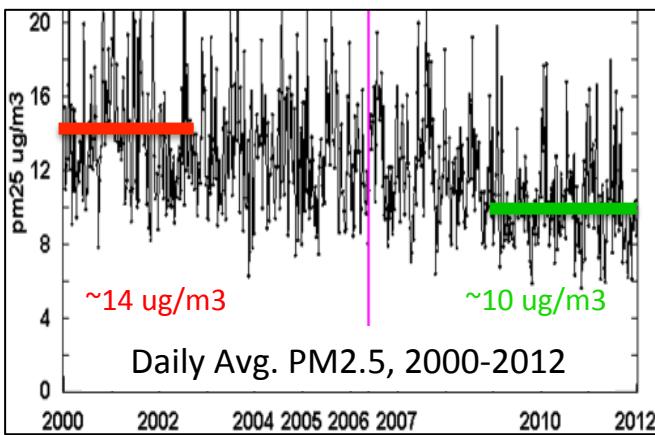
2000-2012: 40% Decline of US PM 2.5

In the 2000-12 period, the avg. PM2.5 conc. declined over the Eastern and Western US.



Over the entire US, the PM 2.5 decline was a remarkable 40%, from 14 to 10 ug/m³

The count of >35 ug observations has declined by factor of 3

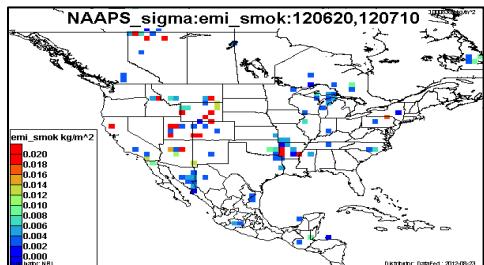


There are much fewer exceedances – fewer EE flags

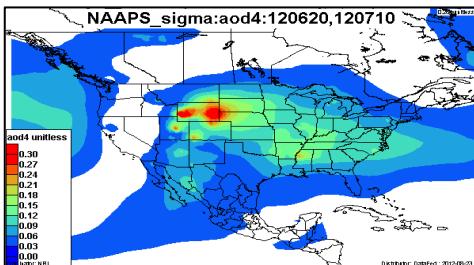
Issue: Will Drought/Smoke be More Intense?

2012: W. US Smoke Highest since 2006

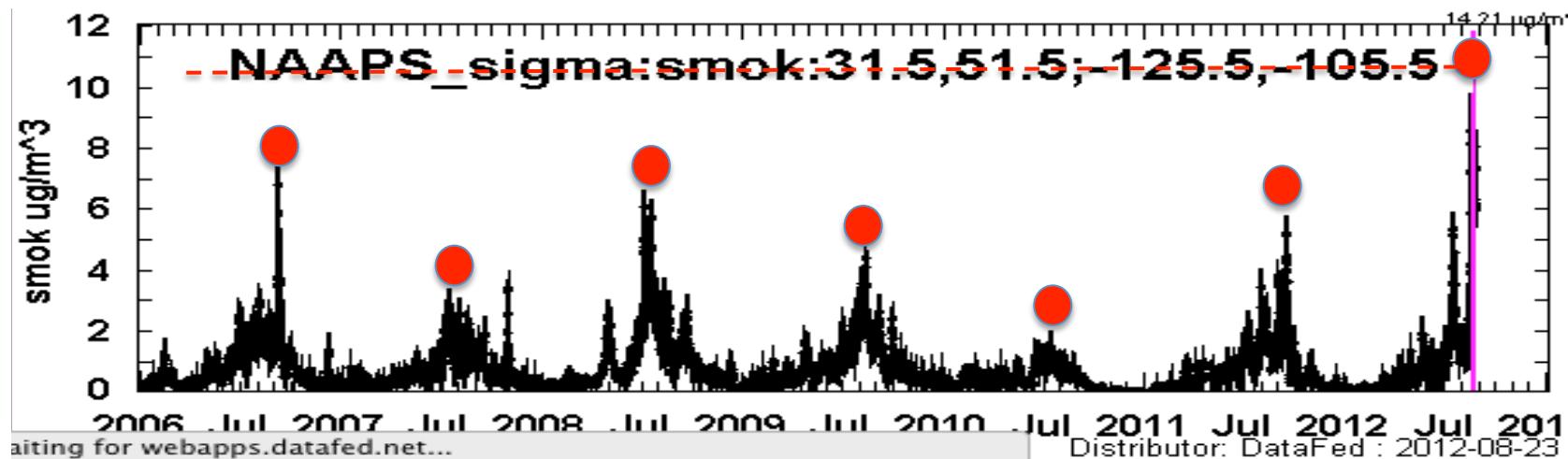
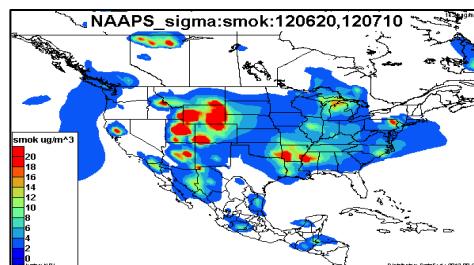
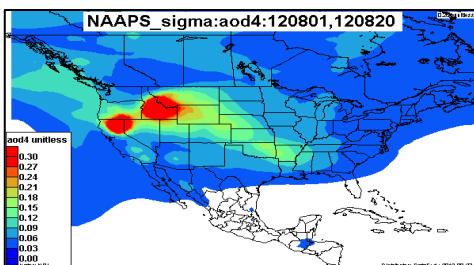
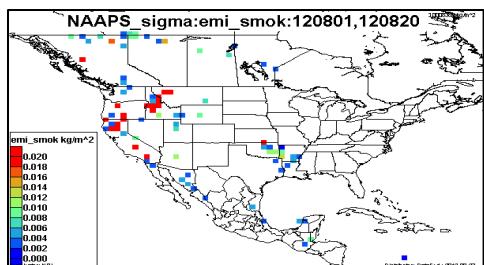
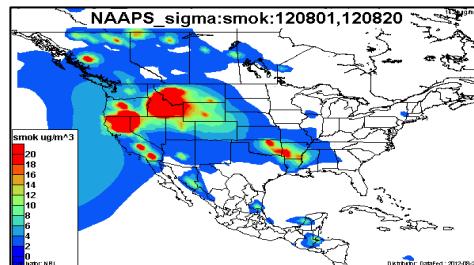
NAAPS Smoke Emission



NAAPS Smoke AOT



NAAPS Surf. Concentration



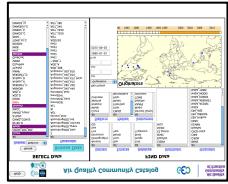
Project Completion Plans, Jan. 2013

- Based on the NAAPS forecasts, **dust and smoke events will be detected** using multiple algorithms.
- **Event forecasts will be syndicated** to subscribers at State air pollution agencies
- The event **DSS will be augmented** with additional NRT satellite and surface-based observations and tools.
- Demonstrate use of **NAAPS as boundary conditions** for regional AQ models

ARL Levels of DataFed Tools and DSS: 2012

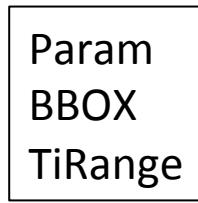
ARL of DataFed Tools

DataFed
Data Pool



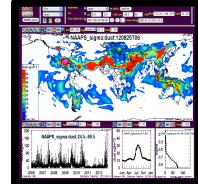
ARL 7

Data
Extractor



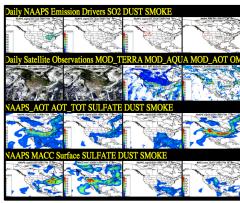
ARL 8

Data
Browser



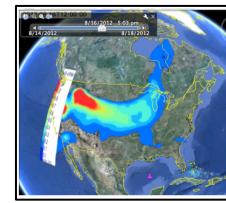
ARL 8

Map
Console



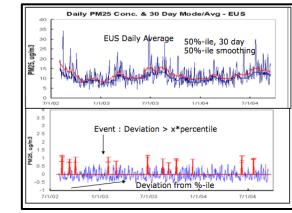
ARL 6

Animator
Tool



ARL 6

Event
Detector



ARL 5

ARL of DSS for Applications

AQ Forecasting: ARL 7

Exceptional Events: ARL 6-7

Regional Haze Rule: TBD

Lessons Learned

- In order to move from ARL 6 (demonstration) to 7-8 (application-at the user), it is **necessary to have 'champions'** with the organizations. They have to **PULL**.
- Whenever possible, **keep connection to the data originator close/live**, so the data can evolve since the user will ask for quality data.
- How could we **connect the connectors** i.e. these NASA AQ-Health integration projects? Data sharing/reuse, creativity by synergy, overall productivity/effectiveness?